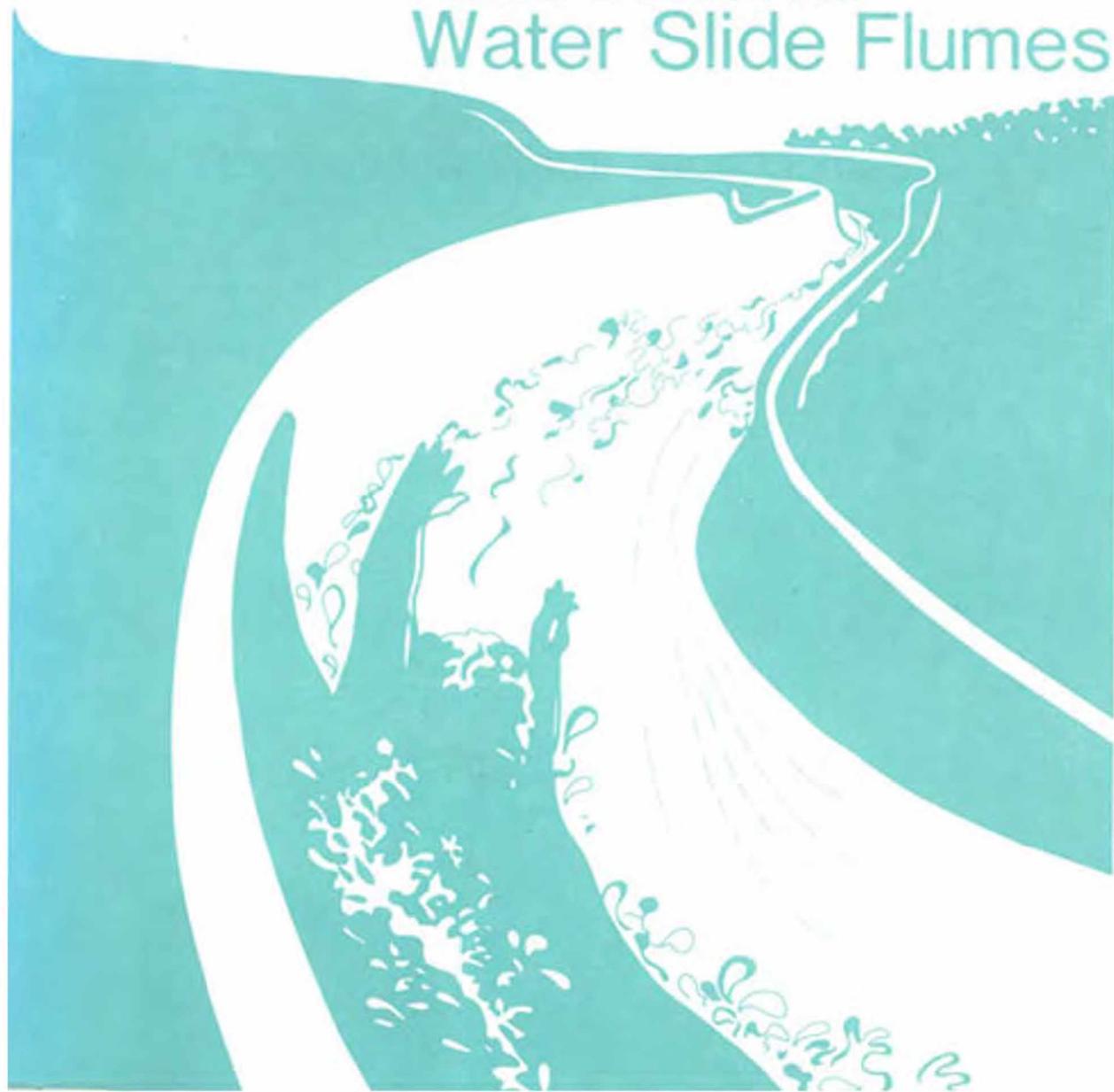


This document is provided by the U.S. Centers for Disease Control and Prevention (CDC) ONLY as an historical reference for the aquatics and public health communities. It is no longer being maintained and the data it contains may no longer be current and/or accurate. The [CDC Healthy Swimming](http://www.cdc.gov/healthyswimming/) website is the most current source of information on safe water, waterborne diseases, best practices and all other water-related information. It should be consulted first at: <http://www.cdc.gov/healthywater/swimming/> .

Persons with disabilities experiencing problems accessing this document should contact CDC-INFO at CDC-INFO@cdc.gov, 800-232-4636 or the TTY number at (888) 232-6348 and ask for a 508 Accommodation PR#9342. If emailing please type "508 Accommodation PR#9342" without quotes in the subject line of the email.

Suggested Health and Safety Guidelines for
**Recreational
Water Slide Flumes**



SUGGESTED HEALTH AND SAFETY GUIDELINES FOR

Recreational Water Slide Flumes

JULY 1981

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
Center for Environmental Health
Environmental Health Services Division
Atlanta, Georgia 30333

PREFACE

The recreational water slide flume industry is expanding into States which do not have adequate regulations to control the health and safety features of these facilities. This publication, therefore, has been prepared to assist State and local health agencies develop practical water slide flume safety and health regulations. These guidelines, along with the appropriate inspection and enforcement procedures, should serve as the foundation for establishing practical regulatory programs. The technical content of the guidelines suggested may have to be modified to meet the particular needs of a State or local agency.

Readers are directed to the American National Standards Institute (ANSI) standards for making buildings and facilities accessible to, and usable by, the physically handicapped. The reference standard is A117.1-1976 (1971), by the ANSI, 1430 Broadway, New York, New York 10018.

This publication would not have been possible without the valuable advice provided by numerous individuals within many organizations. Special thanks are due to the National Swimming Pool Institute (NSPI) for preparing the initial draft of this document and for maintaining liaison efforts with members of the recreational water slide flume industry. Appreciation is extended to the following organizations for reviewing this manuscript:

Swimming Pool Consensus Review Panel, American Public Health Association; Preventable Disease Division, Department of Health Services, State of Connecticut; Division of Personal Environmental Health Services, Department of Health, State of Ohio; Division of Communicable and Venereal Disease, Department of Health, the Commonwealth of Massachusetts; Division of Water Supply, Bureau of Environmental and Occupational Health, Department of Public Health, State of Michigan; and the Sanitary Engineering Section, Department of Health Services, State of California.

CONTENTS

Introduction	
1.1 Objective	1
1.2 General Description of Recreational Water Slide Flumes	1
2.0 Details of Present Experience with Health and Safety Problems with Slides	1
2.1 Structural and Operational Hazards	1
2.2 Chemical Hazards	1
2.3 Bacteriological Hazards	1
3.0 Recommended Design and Construction Criteria	2
3.1 Materials of Manufacture	2
3.2 Structural Design	2
3.3 Dimensional Design	2
3.4 Circulation Systems	3
3.5 Filters	3
3.6 Pumps	3
3.7 Water Makeup Systems	4
3.8 Inlets and Outlets	4
3.9 Piping	4
3.10 Waste Water Disposal	4
3.11 Water Supply	4
3.12 Disinfectant and Chemical Feeders	5
3.13 Toilets and Showers	5
3.14 Visitor and Spectator Areas	5
3.15 Food Service	5
3.16 Electrical Safety and Lighting	5
4.0 Operating Instructions	6
4.1 Competence of Operators	6
4.2 Chemical Operational Parameters	6
4.3 Recommendations on the Use of Elemental Chlorine and Operational Procedures	10
5.0 Recommendations for Monitoring Water Slides	11
5.1 Inspection Policies	11
5.2 Safety Checks	11
5.3 Recommended Procedures for Monitoring Chemical Content	11
5.4 Recommended Bacteriological Sampling of Slide Waters	11
5.5 Bacteriological Analysis of Slide Waters	12
6.0 Recommendations for Identifying and Troubleshooting Health and Safety Problems During the Operation of Water Slides	12
7.0 Emergency Procedures	13
7.1 Chlorine Gas Release	13
7.2 Power Outage	13
8.0 Typical Posted User Safety Warnings for Slide Opera- tional Use	14

TABLE

Chemical Operational Parameters..... 7

FORMS

A Typical First-Aid Report..... 15
B Typical Daily Water Quality Log..... 17
C Emergency Phone Numbers..... 19

Glossary..... 21
Additional Technical Terms..... 22

INTRODUCTION

1.1 Objective

The objective of this document is to provide health and safety officers at the State and local levels with preliminary guidelines for evaluating and approving the design, construction, and operation of recreational water slide flumes (slides), including adequate monitoring techniques and procedures to ensure safe operations.

These guidelines are meant to provide a basic view of water slide flumes from a health and safety standpoint.

Although all slides are similar in general function, they differ in design, construction, and operation to such an extent that all can be considered custom devices. Therefore, any health and safety officer must look beyond these guidelines to uncover problems that may be unique to the particular installation he or she is evaluating.

1.2 General Description of Recreational Water Slide Flumes

Slides are recreational devices designed to provide a descending ride into a splash-down pool at the base of the slide. Low friction on the slide bed or flume is achieved in all designs by providing a flowing water film.

These slides may be cut into the slopes of a natural hillside or into an artificially excavated hill, or they may be supported from level ground by a structure which provides both support strength and proper angle alignment for the slide bed.

A typical slide may consist of one or more flumes, an entry pool, a splash pool, a pump reservoir, and water treatment and pumping facilities.

Water slide flumes are commercial establishments designed for use by the public, with no restrictions placed on use by either children or adults. Manufacturer's guidelines or health agencies, however, may suggest restrictions in certain designs.

2.0 Details of Present Experience with Health and Safety Problems with Slides

Three categories of potential hazards have been identified on the basis of available accident information as unique to slide use and design. These are:

- 2.1 Structural and Operational Hazards
- 2.2 Chemical Hazards
- 2.3 Bacteriological Hazards

2.1 Structural and Operational Hazards

The design, construction, maintenance, and operation of a particular slide have a major influence on both the frequency and the magnitude of potential accidents. These accidents may result in minor cuts, contusions, abrasions, or, in rare cases, serious injury.

Typical structural and operational hazards are given below.

2.1.1 The greatest potential for injuries exists on stairways leading to the top pool and in the concourse area at the top of the slide, where puddling and algae growth in pool drainage,

coupled with a large number of sliders, could cause some of the users to slip.

In addition, they could slip when entering the top pool and when leaving the splash pool, especially where there are no slip-resistant surfaces, no handrails, and no good deck drainage.

2.1.2 Abrasions and cuts are predominantly associated with hand, arm, or torso contact with the wall edge of the flume or the edge of tunnels during a descent. The nature of the injury is associated with the materials of the flume. That is, abrasions are most common in flumes made of concrete that do not have sealants and epoxy paints on the upper portion of the flume walls and top rails, but cuts are associated mostly with fiberglass flumes that have short top rails which allow finger contact with the outer edge of the fiberglass or with poorly butted, sealed, or patched fiberglass sections.

Some cuts have been reported from touching the sharp bottom edges of chain link fences placed too close to the flumes of concrete slides.

2.1.3 Sliders have suffered falls and impact injuries in accidents on the flume and in the splash pool. These accidents are associated with the following circumstances:

- a. Slider hits flume wall when no smooth transition section leads into a turn.
- b. Torso, face, or head hits wall of flume when slider loses control of his or her body or slips off the mat during a slide.
- c. Slider stands up in flume and is struck from behind by another slider.
- d. Sliders ride double on the mat or piggyback.
- e. Adult sliders who are under the influence of alcohol enter the splash pool headfirst in a steep dive.
- f. Sliders hit others in splash pool.
- g. Structural failures cause falls.

2.1.4 No drownings in a splash pool have ever been reported from the normal operation of a slide of any type. At least one fatality, however, resulted when a child crawled into a water return opening which carried water to a holding tank and the recirculation pumps.

2.2 Chemical Hazards

Accident reports indicate potential problems in this area from:

- a. Release of gaseous chlorine by untrained operators, which could result in attendees at the site being exposed to a potentially fatal hazard.
- b. Lack of proper chemical control in the water, which could result in excessive eye irritation.

2.3 Bacteriological Hazards

No illnesses transmitted to the public from slide operations have been reported, but the potential for bacteriological problems is high because of the high flow and aeration rates of the water, which tend to rapidly deplete the free chlorine residual.

Qualified operators must test the chlorine and pH levels quite frequently if a healthy chemical balance is to be maintained.

In addition, flexible or plastic foam used to traverse the flume may, after being stored dry for more than 48 hours, become a site of bacterial growth if it is not sprayed with, or soaked in, pool water with proper chlorine and pH levels.

3.0 Recommended Design and Construction Criteria

3.1 Materials of Manufacture

3.1.1 The materials for components and accessories used in and around slides should be compatible with humans and the environment in which they are installed. These materials should be capable of fulfilling the design, installation, and intended use requirements.

3.1.2 The materials for components and accessories to be used in and around slides should be such that the operational strength of the entire assembly and of each of its components is not adversely affected by exposure to rain, snow, ice, sunlight, local normal temperature extremes, local normal wind variations, expected local air pollution products, and the mechanical, electrical, and chemical environment in and around the slides. "Local normal" temperature extremes and wind variations are defined as the average annual recorded limits for the past 10 years at any slide installation point in the U.S.A., where such statistical information exists in "Statistical Abstract of the United States, 1979," Section 6, Geography and Environment, Bureau of the Census, U.S. Department of Commerce.

3.1.3 Materials selected for components and accessories used in and around slides should be such that all parts with external surfaces and edges that may come in contact with the user are assembled, arranged, and finished (deburred, polished, etc.) so that they will not constitute a cutting, pinching, puncturing, or abrasion hazard in casual contact and intended use.

3.1.4 Materials used for structural support, operating components, and accessories in and around slides should not be toxic to humans or harmful to the environment, and should be chemically compatible with the materials and environment contacted under intended use and reasonable abuse.

3.1.5 The assembled structure, its components, and accessories should be strong enough to prevent structural failure.

3.2 Structural Design

The slide's structural design and materials should be in accord with generally accepted good structural engineering practices and should provide a durable structure which will safely sustain all weights and pressures (dead load, live load, liquid, hydrostatic, and earth pressures) for the expected operating life of the structure. The flumes and pools should

be watertight, and their surfaces should be inert, nontoxic, smooth, and easy to clean. The flumes should be designed or ventilated, or both, to prevent a possible hazardous concentration of toxic disinfectant fumes.

3.3 Dimensional Design

3.3.1 All curves, turns, and tunnels within the path of a slide flume should be designed so that body impact with the walls of the flume or ceiling of a tunnel does not present a hazard. The slide flume should be banked to keep the slider's body safely inside the flume or curve under all foreseeable circumstances.

3.3.2 All slopes within the path of the slide flume should be designed so that the slider's speed does not exceed a level where a safe equilibrium of dynamic forces cannot be maintained on any curve or turn within that path, as specified by 3.3.1.

3.3.3 In sections of the elevated flumes where, contrary to intended use, a slider may stop, there should be safety walls or other provisions to keep the slider from falling out of the flume.

3.3.4 The construction, the dimensions, and the mechanical attachment of slide flume bed components should be such that the surface of the slide flume is continuous and smooth for the entire length.

3.3.5 Wall thickness of flumes should be designed so that the continuous and combined action of hydrostatic, dynamic, and static loads and normal environmental deterioration do not cause structural failures which could result in injury or continually require patchwork, which would weaken the strength of the original structure.

3.3.6 Flume exit sections should be designed to assure safe entry speeds, angles, and stopping distances.

3.3.7 The distance between the side of a flume exit and a splash pool side wall should be at least 5 feet. The distance between sides of adjacent flume terminuses should be at least 6 feet. The distance between a flume exit and the opposite side of the splash pool, excluding steps, should be at least 20 feet.

a. **High-Speed Slides** Special provisions should be made in flume exit design, pool depth, and pool width, measured from flume exit, to safely accommodate slides specifically designed with greater slopes or other special features which allow an unusually rapid descent.

b. **Multiple-Exit Slides** Multiple-exit slides should have parallel exits or be constructed so that their centerlines do not intersect for a distance of at least 20 feet from the exits of each flume. If slides with nonparallel exits discharge bathers at a high speed, the centerlines should not intersect for at least 30 feet.

3.3.8 Flumes should terminate either at a depth of at least 6 inches below the splash pool's operating water surface level or no more than 2 inches above the water surface, provided the flume is level for a distance of at least 10 feet from its exit end.

3.3.9 A flume exit system should provide safe entry into the splash pool. Present practices for safe entry include a water backup, a deceleration distance, and an attitude control. Other methods are acceptable as long as safe exit velocities and proper user attitudes are assured under normal use.

3.3.10 Splash pool depth at the end of a flume should be 3 feet. This depth should be maintained in front of the flume for a distance of at least 20 feet, from which point the splash pool floor may have a constant slope upward to the minimum water depth. These slopes should be no more than 1 foot in 7 feet. If special exit systems that assure safe exit from the flume and safe entry to the splash pool are used, the 3-foot depth and minimum maintenance distance for this depth can be waived.

3.3.11 Decks along the exit side of the splash pool should be at least 10 feet wide, have slip-resistant surfaces, and be sloped between 4 to 6 inches in 10 square feet away from the pool to drainage or to deck drains. Decks should not retain standing water. If deck drains are used, at least one floor drain for every 100 square feet of surface should be provided.

Any decks at the entrance to the top of the flume should be drained as described above.

Decks along the side opposite the pump reservoir should be at least 4 feet wide and should have the same slip resistance and drainage requirements as top and splash pool decks.

The pump reservoir area should be accessible, for cleaning and maintenance, by a 3-foot minimum width walkway deck.

3.3.12 A 4-foot minimum width walkway, walkway steps, or a stairway should be provided between the plunge pool and the top of the flume.

Walkways and steps should be well drained, non-slippery, and separated from the flume by a physical barrier, set back far enough from the operating flume so that users cannot contact it on the way down.

3.3.13 All stairways used as part of a slide should not retain standing water and should conform to the requirements of local building codes.

3.3.14 The pump reservoirs should have sufficient volume to contain at least 2 minutes of combined flow from all water treatment and flume pumps and enough water to insure that the lower splash pool will maintain a constant water depth.

3.4 Circulation Systems

3.4.1 The filtration equipment should be of adequate size to "turn over" the entire system's water at least once every hour. It should be capable of returning the pool water to a turbidity of 0.50 Jackson Turbidity Units at least once during the 8 hours after the peak user load. In any event, the bottom of the splash pool should be clearly visible at all times.

3.4.2 Pool water should be drained from the equipment and the exposed face piping by removing drain plugs, manipulating winter drain valves, or by other methods.

3.4.3 All equipment should have installation and operation instructions.

3.4.4 A flow meter should be provided on the exit side of the filter system. A pressure gauge should be provided on the influent side and on the effluent side of all filters.

3.4.5 Materials used in the circulation system should comply with the requirements of the latest joint National Swimming Pool Institute-National Sanitation Foundation standards.

3.4.6 In climates subject to freezing temperatures, the splash pool shell and appurtenances, piping, filter system, pump and motor, and other components should be designed, constructed, and operated to eliminate damage from freezing.

3.5 Filters

3.5.1 Filters should be designed to maintain pool water under anticipated operating conditions in accordance with section 3.4.1 of these guidelines. Filters should be designed so that filtration surfaces can be easily restored to their design capacity and efficiency.

3.5.2 A means for releasing air which enters the filter tank should be provided. This may be automatic or manual. Where an upflow design is used, air must be expelled through the filter tank. Any filters incorporating an automatic internal air release as their principal means of air release must have lids which provide a slow and safe release of pressures. Any separation tank used in conjunction with a filter tank must have a manual means of air release or a lid which provides a slow and safe release of pressures.

3.5.3 A statement warning personnel not to start the filter pump without first opening the air release should be clearly visible on the separation tank in the area of the air release.

3.5.4 Piping furnished with the filter should be capable of withstanding three times the working pressure. The suction piping should not collapse when flow on the suction side of the pump is completely shut off.

3.6 Pumps

3.6.1 Pumps and motors should be provided to circulate the water in the splash pool and slide. Performance of all filter pumps should meet the conditions of flow required for filtering and cleaning (if applicable) the filters against the total head developed by the complete system. Flume pumps and motors should be of adequate size, as specified by the flume manufacturer, and should meet all NSPI standards for swimming pool pumps.

3.6.2 The pump suction header should have a gauge which indicates pressure. The gauge should be installed as close to the pump inlet as possible.

3.6.3 All pressure filter systems should have suitable removable strainers or screens before all circulation pumps to remove solids, debris, hair, lint, and other materials. Water entering a pump should pass through the screen.

3.6.4 Pump units should be accessible for inspection and service. Replacement parts should fit with existing parts without mounting holes having to be redrilled or the replacement part having to be otherwise altered.

3.6.5 Where a mechanical seal is provided, components of the seal should be corrosion resistant and capable of operating under conditions normally encountered in slide operation.

3.6.6 Proper direction of rotation for the pump should be clearly indicated by an arrow on the pump data plate, on a separate plate attached to the pump, or cast into the pump itself.

3.6.7 All motors should have, as a minimum, an open drip-proof enclosure (as defined by the latest National Electrical Manufacturers Association standards) and should perform satisfactorily under conditions normally encountered in slide operation.

3.6.8 All motors should have thermal overload protection, either built in or in the line starter, to provide locked rotor and running protection.

3.6.9 The motor frame should be properly grounded.

3.6.10 Pumps used on slides should comply with the latest joint National Swimming Pool Institute-National Sanitation Foundation performance standards in effect at the time the pump is installed.

3.7 Water Makeup Systems

3.7.1 A surge-free automatic water makeup system should insure that the water in the splash pool is maintained at the proper level.

3.7.2 When surface skimmers are used as the sole overflow system, at least two skimmers should be used. Skimmers should be provided for each 500 square feet (46.5 m²), or fraction thereof, of the pool surface area. When two or more skimmers are used, they should maintain effective skimming action over the entire surface.

3.7.3 Permanently installed surface skimmers should comply with the latest joint National Swimming Pool Institute-National Sanitation Foundation performance standards in effect at the time the makeup system is installed.

3.8 Inlets and Outlets

3.8.1 Pool inlets and outlets should produce a uniform circulation of water to maintain a uniform disinfectant residual.

3.8.2 The number of inlets should be based on either one inlet per 600 square feet (55.7 m²) of pool area or one inlet per 15,000 gallons (56,780 liters) of pool capacity, whichever is greater.

3.8.3 At least one outlet should be provided at the lowest point of the floor to completely drain the entire floor. When the main outlets for pool pump suction are installed in the pool floor near one end, the spacing should not be greater than 20 feet (6.1 m) on centers, and an outlet should be provided not more than 15 feet (4.57 m) from each side wall. The total velocity through grate openings should not exceed 2 feet per second (61 cm/second). Grate openings should be designed to prevent fingers and toes, etc., from being trapped in the openings.

3.8.4 Outlets on pump suction, except those for skimmers, should be covered with suitable protective grates that cannot be removed except with tools.

3.8.5 An over-the-rim spout, if used, should not create a hazard. Its open end should have no sharp edges and should not protrude more than 2 inches (5.1 cm) beyond the edge of the pool.

3.8.6 Inlets from the circulation system should not project enough to cause harm to the splash pool user.

3.9 Piping

3.9.1 The size of the slide circulation piping should permit the rated flows for filtering and cleaning without exceeding the total head developed by the pump at the rated flow.

3.9.2 The water velocity should not exceed 10 feet per second (3.05 m/second) for discharge piping, except for copper pipe, where the velocity should not exceed 8 feet per second (2.44 m/second), and asbestos cement pipe, where the velocity should not exceed 6 feet per second (1.83 m/second). Suction velocity for all piping should not exceed 6 feet per second (1.88 m/second).

3.9.3 All piping around slides which is subject to damage by freezing should be sloped for adequate drainage and supported at sufficiently close intervals so that water will not be trapped in sags between the supports. If needed, swing joints or other means for expanding or contracting pipes should be provided.

3.10 Waste Water Disposal

3.10.1 Overflow water should be returned to the filter system or discharged to a waste system approved by local authorities. Where perimeter overflow water discharges into a sanitary sewer, a suitable air gap at least 1 1/2 times the discharge diameter should be provided to create a gravity drip which has no direct mechanical connection into the sewer.

3.10.2 When an air gap is impractical, a relief manhole with a grated cover may be constructed in the perimeter overflow main waste line, the clear area of which should be twice the area of the main waste piping. It should be at a level so that the waste flow in the line will rise in the manhole and overflow at ground level not less than 2 feet (61 cm) below the level of the perimeter overflow lip.

3.10.3 Sewage from public restrooms should be discharged into a sanitary sewer, a septic tank, or other waste lines which meet with the approval of the local authorities.

3.10.4 Filter backwash water may be discharged into a sanitary sewer through an approved air gap, or into an approved subsurface disposal system, or by other means approved by local authorities.

3.11 Water Supply

3.11.1 The water supply serving the pool should meet the requirements of the appropriate authority.

3.11.2 All portions of the potable water supply system serving the slide and auxiliary facilities should be protected against backflow.

3.11.3 Potable water introduced into the slide circulation system, either directly or through the recirculation system, should be supplied through an air gap (American National Standards Institute – A40.4-1942) or other approved means.

3.12 Disinfectant and Chemical Feeders

3.12.1 Disinfectants used in flume and pool water should provide a disinfecting residual in the pool water. Chlorine or chlorine compounds are most frequently used for this purpose, but other bactericidal agents or apparatuses are acceptable if registered by the U.S. Environmental Protection Agency. (Refer to Chemical Operational Parameters, Section 4.2.)

3.12.2 Adequate and appropriate equipment for introducing a disinfectant into the recirculating system should be provided. This equipment should be of sufficient capacity to maintain appropriate disinfectant residual levels at all times (see Section 3). The DPD (diethyl-p-phenylenediamine) or other suitable free chlorine test method is suggested as a means of testing for the free chlorine residual.

3.12.3 Feeding equipment should be enduring in quality and capable of permanently and precisely feeding the required quantity of disinfecting agent to the pool water. The disinfecting material used should be subject to field-testing procedures, which are simple and accurate.

3.12.4 Hypochlorinators or other adjustable-output rate chemical-feeding equipment should conform to the joint National Swimming Pool Institute-National Sanitation Foundation Standard #19, relating to "Adjustable Output Rate Chemical Feeding Equipment and Flow Thru Chemical Feeding Equipment for Swimming Pools."

3.12.5 Capacities of chemical feeders should be adequate to conform to the requirements of Section 3.12.2.

3.12.6 Personnel responsible for the operation of disinfecting equipment should be properly trained in equipment operation, field test procedures, and emergency procedures. (See Sections 4 through 7.)

3.13 Toilets and Showers

3.13.1 The minimum criteria for bathhouse facilities should be based upon the following chart:

PLUMBING FIXTURES RECOMMENDED FOR WATER SLIDE FLUMES

No. of Fixtures	Commodes		Urinals (Males)	Lavatory Per Male/Female	Showers Per Male/Female
	Male	Female			
1	1-199	1-99	1-199	1-199	1-99
2	200-399	100-199	200-399	200-399	100-199
3	400-600	200-399	400-600	400-750	200-299
4		400-600			
	Over 600, one fixture for each additional 300 males and females.		Over 600, one fixture for each 300 males.	Over 750, one for each additional 500 persons.	Over 299, one for each additional 100 persons.

3.13.2 Tempered water only should be provided at all shower heads. Water heater and thermostatically controlled mixing valves should be capable of providing 2 gpm (7.6 liters per minute) of approximately 90° F. water to each shower head. The heater and valves should be inaccessible to sliders.

3.13.3 Soap dispensers for liquid or powdered soap should be provided at each lavatory. Dispensers must be all metal or all plastic, with no glass.

3.13.4 Unbreakable mirrors should be provided over each lavatory. Toilet paper holders should be provided at each water closet combination.

3.13.5 Fixtures should be installed in accordance with local plumbing codes and properly protected against back siphonage.

3.13.6 Fixtures should be designed for easy cleaning. Frequent cleaning and disinfecting should not cause damage.

3.13.7 Sanitary napkin dispensers should be installed in toilet and shower areas for use by females.

3.14 Visitor and Spectator Areas

The spaces used by visitors and spectators should be distinctly and absolutely separated from those spaces used by sliders. Visitors and spectators in street clothes may be allowed within the perimeter enclosure if they are confined to an area separated from the space the sliders use.

3.15 Food Service

No food or drinks should be permitted in the immediate area of the flumes and pools or on the decks, stairs, and walkways surrounding the flumes and pools. Food and beverages should be allowed in the visitor and spectator area or in a similarly separated snack area for sliders. Trash containers should be provided to keep litter off the decks and walkways and out of the flumes and pools.

3.16 Electrical Safety and Lighting

3.16.1 The latest National Electrical Code, as published by the National Fire Protection Association, or a local code, whichever is more restrictive, should be used for the wiring and grounding of all electrical equipment associated with a slide and for the grounding of all metallic appurtenances.

3.16.2 Whenever slides are operated after dark, artificial lighting should be provided in upper and lower pool and deck

areas, walkways, stairways, and flumes, as recommended by local codes or *The Illuminating Engineering Society Lighting Handbook*.

4.0 Operating Instructions

The manufacturer or the general contractor of the slide should provide the operator with a detailed written operational manual, or guide, for all phases of operations and normal maintenance of each component of the system. The guide should be kept in a secure area and made available to each employee as needed. This guide should include, as a minimum, the following information:

- a. Customer safety rules to be posted at the entrance to flumes.
- b. Required training or certification levels of upper and lower pool supervisors.
- c. The number and type of operating personnel.
- d. Specific work statements for each employee.
- e. Recommendations on the safe handling of crowds during emergencies.
- f. Slide maintenance and cleanup.
- g. Disinfectant operation.
- h. Chlorine cylinder changing procedure (if applicable).
- i. Pump operating instructions.
- j. Backwash procedure.
- k. Operating instructions for vacuum filters (if applicable).
- l. Filter pit draining and cleaning procedure.
- m. Water test instructions—frequency of testing, method of test, interpretation of results.
- n. Filter checks.
- o. Record-keeping for health department.
- p. First-aid reports.
- q. Emergency phone numbers.
- r. Equipment and operational troubleshooting instructions.
- s. Safe repair practices for flume and decks.

4.1 Competence of Operators

Having properly trained and conscientious employees on site is the most important safety factor in the operation of slides.

At least one person who has completed the Standard First Aid and Personal Safety course, as offered by the American National Red Cross, or the equivalent should be on duty at all times during operating hours. This person should also be competent in carrying out any emergency procedures peculiar to the slide he or she is operating.

4.1.1 Splash Pool Supervisor. The principal function of the lower pool supervisor is to serve as a lifeguard. The lower pool supervisor should be qualified in both first-aid and life-saving techniques through Red Cross training or the equivalent.

The lower pool supervisor should also control crowds in the splash pool by keeping sliders moving into and out of the lower pool as quickly and in as orderly a manner as possible; he or she should also control any horseplay, running, or unsafe behavior in the lower flumes, the splash pool, and the pool decks.

4.1.2 Upper Pool Supervisor. The principal functions of the upper pool supervisor are to control crowds and sliders starting from the upper pool and flume, control the timing of each person on the slide, and supervise all visible portions of the flumes.

4.1.3 Responsibility for Chlorination and Water Treatment.

A specific person on each shift should be responsible for disinfection and water treatment operations and should be thoroughly trained in the performance of routine operations, including emergency procedures and leak-control problems. If possible, these people should complete training courses on swimming pool operations, given through local departments of health. A typical reference text available for such training is *Swimming Pool Operators Handbook*, published by the National Swimming Pool Foundation. This text is available through the National Swimming Pool Institute, 2000 K Street, N.W., Washington, D.C. 20006. Another reference is *Swimming Pools—Safety and Disease Control Through Proper Design and Operation*. This manual is available through the Environmental Health Services Division, Center for Environmental Health, Centers for Disease Control, Atlanta, Georgia 30333. As an alternative, they should be trained by a professional operator.

The facility should not be in operation without such a person in attendance. No one else should be responsible for chlorination or water treatment operations.

4.1.4 Responsibility for Circulation and Filter System Operation.

A specific person on each shift should be made responsible for circulation and filter system operation, checks, maintenance, backwash, and cleaning. This person should be trained by a professional operator or an expert in swimming pool operations and should carry out all scheduled cleanings and maintenance on the circulation and filter systems.

4.2 Chemical Operational Parameters

The table on pages 7-9 sets forth the suggested operational parameters for proper chemical treatment and maintenance of both flume and pool waters. Because of high aeration rates and potentially high slider loads in the lower pool, tests for water quality and chemical balance should be made every hour the facility is operating.

Proper water balance should be obtained each day before the facility is opened to the public. Chemical treatment alone will not produce sanitary pool water. A filtration system, in proper operational condition, is also needed to attain clean and clear pool water.

TABLE: CHEMICAL OPERATIONAL PARAMETERS
Mg/1 (ppm)

	MINIMUM	IDEAL	MAXIMUM	COMMENTS:
A. DISINFECTANT LEVELS				
1. Free chlorine, ppm	1.0	1.0–1.5	3.0	NOTE: Chlorine should be maintained at this level continually. Superchlorinate regularly. See F.3 below.
2. Combined chlorine, ppm	None	None	0.2	If combined chlorine is too high, you may have: <ul style="list-style-type: none"> • Sharp chlorinous odors • Eye burn • Algae growth • Bacteria growth (Combined chlorine is eliminated by superchlorination.)
3. Bromine, ppm	1.0	1.5	3.0	NOTE: Health department officials should be consulted before bromine is used.
4. Iodine, ppm	1.0	1.5	5.0 (includes all forms)	NOTE: Health department officials should be consulted before iodine is used. May discolor water; ineffective against algae.
B. CHEMICAL VALUES				
1. pH	7.2	7.5	7.8	If pH is: TOO HIGH <ul style="list-style-type: none"> • Lower chlorine efficiency • Scale formation • Cloudy water • Increased chemical demand • Eye discomfort TOO LOW <ul style="list-style-type: none"> • Rapid dissipation of chlorine • Plaster/concrete etching • Eye discomfort • Corrosion of metals
2. Total alkalinity (ppm as CaCO ₃)	60	100	200	If total alkalinity is: TOO LOW <ul style="list-style-type: none"> • pH bounce • Corrosion tendency TOO HIGH <ul style="list-style-type: none"> • Cloudy water • Increased scaling potential • pH too high
3. Undissolved solids	None	None	None	If undissolved solids are: TOO HIGH <ul style="list-style-type: none"> • Filter may not work properly. • Water may be un-sightly.
4. Dissolved solids, ppm	300	—	1500*	If dissolved solids are: TOO LOW <ul style="list-style-type: none"> • Total alkalinity may be too low. • Water may be poorly buffered. TOO HIGH <ul style="list-style-type: none"> • Chlorine may be less effective. • Scaling may occur. • Fresh water should be added. • Salty taste • Dull water • Chemical balance difficult to maintain

*This limit has not been confirmed yet.

	MINIMUM	IDEAL	MAXIMUM	COMMENTS
5. Hardness (ppm as CaCo ₃)	50	125	500	If hardness is: TOO LOW <ul style="list-style-type: none"> •Plaster or concrete etching may occur. • Corrosion TOO HIGH <ul style="list-style-type: none"> • Scaling may occur. • Water has bad "feel." • Short filter runs
6. Copper, ppm	None	None	0.3	If copper content is: TOO HIGH <ul style="list-style-type: none"> • Staining may occur. • Water may discolor. • Chlorine may dissipate rapidly. • Filter may plug. • May indicate pH too low, corrosion, etc.
7. Iron, ppm	None	None	0.3	If iron content is: TOO HIGH <ul style="list-style-type: none"> • Staining may occur. • Water may discolor. • Chlorine may dissipate rapidly. • Filter may plug.

C. BIOLOGICAL VALUES

1. Algae	None	None	None	If algae are observed: <ul style="list-style-type: none"> • Superchlorinate or shock treat. • Supplement with brushing and vacuuming. • Maintain adequate free chlorine residual. • Use approved algaecide according to label directions.
2. Bacteria	None	None	Refer to local health code.	If bacteria count exceeds Health Department requirements: <ul style="list-style-type: none"> • Superchlorinate and follow proper maintenance procedures. • Maintain proper free chlorine residual.

D. STABILIZER

1. Cyanuric acid, ppm	30	---	150 except where limited by Health Dept. requirements, often to 100 ppm.	If stabilizer is: TOO LOW <ul style="list-style-type: none"> • Chlorine residual may be rapidly destroyed by sunlight. TOO HIGH <ul style="list-style-type: none"> • May exceed Health Dept. regulations. NOTE: Consult your health agency for use of stabilizers.
-----------------------	----	-----	--	---

	MINIMUM	IDEAL	MAXIMUM	COMMENTS:
E. ALGAECIDES				
1. Quaternary algaecides, ppm	1	3	5	May not be permitted. Health Department officials should be consulted. Quats may create a chlorine demand. Ineffective on some algae. May cause foaming.
2. Copper-based algaecides, (nonchelated), ppm	0.1	0.2	0.3	Ineffective against some algae. Health Department officials should be consulted before using. May contribute to staining.
3. Copper-based algaecides, ppm	0.1	1.0	3.0	See comment above.
4. Silver-based algaecides, ppm	0.5	1.5	3.0	Precipitates with cyanuric acid. Ineffective against some algae. Health Department officials should be consulted before using.
F. REMEDIAL PRACTICES				
1. Superchlorination frequency	Monthly	When combined, chlorine is 0.2 ppm or more.	Weekly	
2. Required superchlorination chlorine, ppm	5	10	---	
3. Required shock treatment chlorine, ppm	10	---	---	
4. Floccing frequency	---	When needed	---	NOTE: Floc only to maintain water clarity and supplement filtration.
5. Water replacement	---	---	---	
G. TEMPERATURE				
1. Temperature, °F	---	---	104°	
H. WATER CLARITY				
1. Water turbidity, JTUs	0	0.5 or less	1.0	If water turbidity is: TOO HIGH <ul style="list-style-type: none"> • Chlorine level may be too low. • Filtration system may be inoperative. • Too turbid water may lead to drownings, because of reduced visibility.

4.3 Recommendations on the Use of Elemental Chlorine and Operational Procedures

Although chlorine solution (hypochlorite) is preferable from a safety standpoint, gaseous chlorine may be approved as the disinfectant. If gaseous chlorine is used, however, these guidelines should be followed.

4.3.1 General. Chlorine is one of the chemical elements. The gas has a characteristic odor, is greenish-yellow, and is about 2 1/2 times as heavy as air. Chlorine is shipped in steel cylinders which meet the specifications of the U.S. Department of Transportation; standard sizes contain either 100 or 150 pounds of chlorine. In the cylinder, the chlorine has both a liquid and a gas phase. All cylinders are equipped with the Chlorine Institute Standard Chlorine Cylinder Valve. Chlorine is a "hazardous material," subject to Department of Transportation and Environmental Protection Agency regulations. Users must be informed about proper procedures for handling chlorine and about emergency procedures. Detailed information is available from chlorine suppliers and the Chlorine Institute, 342 Madison Avenue, New York, New York 10017.

4.3.2 Equipment and Installation. Chlorination equipment should be located so that an equipment failure or malfunction will have a minimum effect on an emergency evacuation of patrons.

The chlorinator, cylinders of chlorine, and associated equipment should be housed in a reasonably gastight and corrosion-resistant area, with an adequate floor area. Cylinders should be securely fastened to a wall or post. Except for chemicals used to check chlorine leaks, no other chemicals should be stored in the chlorine enclosure.

It is strongly recommended that enclosures be located at ground or aboveground level. If the enclosure must be installed below grade, it should have airtight ducts from the bottom of the enclosure to atmosphere in an unrestricted area, a motor-driven exhaust fan capable of producing at least one air change per minute, and automatic louvers of good design near the top of the enclosure for admitting fresh air. The enclosure should be inaccessible to casual slide users and, if possible, locked. All keys should be kept on the premises so that they will be readily available when needed by servicing personnel.

Containers may be stored indoors or outdoors. Storage areas should: (a) minimize external corrosion, (b) be clean and free of trash, (c) not be near an elevator or ventilation system, and (d) be away from elevated temperatures or heat sources. Full and empty cylinders should be segregated and tagged.

Contents of a chlorine cylinder can be determined only by weight; therefore, facilities should include a scale suitable for weighing the cylinders. A cylinder should be changed only after weighing proves that its contents have been exhausted.

An automatic chlorine leak detector should be installed, especially in below-grade installations.

Respirators approved by the National Institute for Occupational Safety and Health should be provided for protection against chlorine.

At least one approved self-contained breathing apparatus should be provided. Respiratory equipment should be mounted outside the chlorine enclosure and filter cartridges replaced after each use.

Elemental chlorine feeders should be activated by a booster pump, with recirculated water. The booster pump should be interlocked to the filter pump to prevent the feeding of chlorine when the recirculation pump is not running.

Connections from the cylinders to the system depend on the type of chlorinator used and should comply with the chlorinator manufacturer's recommendation.

Electrical switches for the control of artificial lighting and ventilation should be on the outside of the enclosure, adjacent to the door.

4.3.3 Operational Procedures. A specific person should be responsible for chlorination operations and should be trained in the performance of routine operations, including emergency procedures and leak-control procedures.

A safety chart should be posted in or near the chlorine enclosure, and a second chart should be in the pool office near the telephone. Such charts are available from many suppliers and from the Chlorine Institute, 342 Madison Avenue, New York, New York 10017. The telephone number of the chlorine supplier should be shown on these charts.

Chlorine cylinders must be handled with care. Valve protection caps and valve outlet caps should be in place at all times, except when the cylinder is connected for use. Cylinders must not be dropped and should be protected from falling objects. Cylinders should be used on a first-in, first-out basis. Fresh washers should be used each time a cylinder is connected.

As soon as a container is empty, the valve should be closed and the lines disconnected. The outlet should be promptly capped and the valve protection hood attached. The open end of the disconnected line should be plugged or capped promptly to keep atmospheric moisture out of the system.

Although chlorine suppliers make every effort to furnish chlorine in properly conditioned cylinders, chlorine gas leaks may still occur. Operating personnel should be informed about leak-control procedures.

To find a chlorine gas leak, tie a cloth soaked in ammonia to the end of a stick and hold the cloth close to the suspected area. If chlorine gas is leaking, a white cloud will form. Water should never be used on a chlorine leak. The corrosive action of chlorine and water will make the leak worse.

Chlorine Institute Emergency Kit A, available from chlorine suppliers, contains devices for capping leaks at cylinder valves and some leaks in the cylinder wall. Further information on these kits and training slides demonstrating their use are available from the Institute.

5.0 Recommendations for Monitoring Water Slides

The routine inspection of slides is basically an inventory of operations and maintenance procedures carried out at the slide. An important goal of this inspection is the detection of operational, structural, and equipment defects which exist because of poor design, operation, and maintenance. Those defects most likely to cause injury or illness should be corrected first.

5.1 Inspection Policies

5.1.1 Frequency of Inspection. During the operating season, it is essential that a health official inspect the slide at least once a week. The suggested intervals are for the average slide. Less frequent or more frequent inspection might be in order for the unusual facility.

5.1.2 Time of Inspection. Inspections at times of least use and most use are as valuable in this field as they are in other fields of environmental health (for example, restaurant inspection). Operational problems, such as difficulty in maintaining disinfectant residuals, will necessitate review during high loading, whereas problems of backwashing and flume structural soundness might be solved by inspection during low loading or before the slide is opened when the flumes are dry.

5.1.3 Inspection Routine. The most efficient technique is one that will permit a thorough inspection in the least possible time without excessively retracing steps. One suggested technique is to review the service buildings first, proceed to the flume area when it is dry, then to the pool area and pool tank, and finish with an inspection of the equipment room, or rooms.

The pool manager or equipment operator should accompany the person making the inspection. This will increase the effectiveness of the inspection. If possible, the facility should be inspected in the morning before the water is circulated and later in the day after operational equilibrium has been attained and heavy usage can be observed.

5.2 Safety Checks

5.2.1 Flumes. The person making the walkdown inspection of flumes should check for loose railings, leaking seals at the butt-joints, rough patching of cracks or joints, absence of, or loose, guards on the turns, unusual movement of the flume bed when walked on, the growth of algae on wooden flume support structures, sharp edges on the flume safety rails, the projection of scrub growth close to flume troughs, the projection of any structure (for example, a chain link fence) into the flume troughs, and a smooth clear view of the splash pool at the exit of the flume.

Observations during flume operation should include the movement of users, height of users' bodies on side walls during turns, user impact with flume walls, and user safety during the exit into the splash pool. A proper and steady flow rate for flume water is an important safety feature for slow sliders in the high slope portions and turns.

These safety features at the flume exit should be especially noted; a splash pool shallow enough to prevent children from

drowning, enough room to avoid impact with other sliders and to afford safe deceleration, and an exit posture that prevents head injury upon entering the splash pool.

5.2.2 Lower Pool and Pool Area and Decks. The problems of pool surroundings, puddling on decks, spectator control, pool structure, pool fittings and appurtenances, and water quality will be of major importance.

Testing the disinfectant level and pH will be a routine procedure.

Ordinarily, other chemical tests of the pool water will not be done routinely, but testing for hardness with a field kit may be useful. These kits are available commercially.

The clarity of splash pool water is ordinarily acceptable if no turbidity is noted and bottom detail is clearly visible.

Bacteriological sampling, normally done at this time, is described in 5.4 and 5.5 below.

5.2.3 Gas Chlorine Rooms. Problems in the gas chlorine storage room may be critical to the safety of slide users, and the storage room should be carefully checked on each inspection.

Inspectors should check for proper ventilation; cleanliness; the storage of other chemicals, especially oxidizers, in the gas chlorine room; proper operation and maintenance of the scale; location of electrical switches; proper warnings and emergency instructions inside and just outside the door to the storage room; and posted instructions on how to properly change chlorination cylinders. Inspectors should check for chlorine leaks with ammonia (at the cylinder valve packing and at the head gasket seal between the chlorinator and the chlorine cylinder valve). Chlorine leaking out the vent may indicate a leak at the safety shutoff valve. Proper gas masks should be on the premises, and, if possible, in an area least affected by the gas and where operators have ready access to them.

5.3 Recommended Procedures for Monitoring Chemical Content

All tests for chemical content of flume water are done with standard test kits. Local health departments and local distributors of swimming pool equipment can give advice on proper test kits. Each kit is supplied with specific use instructions and pass-fail criteria. These are also noted in the table on pages 7-9 and are specified for particular localities in local sanitation codes.

5.4 Recommended Bacteriological Sampling of Slide Waters

Local health and sanitation codes provide detailed instructions on sampling techniques and safe quality limitations. The following represents a general example of bacteriological sampling of pool waters.

- a. **Sample Bottles.** All sample bottles must be sterilized and treated with sodium thiosulfate to reduce the chlorine present in the water at the moment the sample is collected.
- b. **Collection of Samples**
 - (1) **Time of collection** - Generally, samples should be collected only when the pool is in use and, prefer-

ably, during periods of heaviest use. The hour and day of the week should be varied to obtain, over a period of time, a representative cross section of the sanitary quality of the pool.

- (2) **Place of collection** - It has often been suggested that the pool should be sampled at the shallow end because the quality of the water is poorest there. This is not necessarily true. The sampling point should be varied.

It is neither necessary nor desirable for a person to collect a sample from the middle of the pool to avoid collecting heavily chlorinated return water. This problem may be avoided by collecting samples at points between return-water inlets.

- (3) **Technique of sampling** - The first step in sampling should be to carefully remove the cap and stopper from the bottle without touching the inner surfaces of the stopper. The sterile bottle should be held near its base at a 45° angle and filled in one slow sweep down through the water, with the mouth of the bottle always ahead of the hand. Care should be taken to avoid contamination of the sample by floating debris. The stopper and cap should then be replaced. The bottle must not be rinsed in the pool because such rinsing will remove the sodium thiosulfate.

- c. **Disposition of Sample.** The sample should be taken to the laboratory for processing as soon as possible, preferably within 6 hours. The samples should be refrigerated immediately upon collection, and if they are not immediately taken to the laboratory for assay, they should be held at 10° C. (50° F.). Pertinent data, such as sampling time, location of sample, sampler's identification, and desired analysis, should accompany the sample.

5.5 Bacteriological Analysis of Slide Waters

5.5.1 Tests for Bacteriological Quality of Water

- a. **Presence of the coliform group of organisms.** The coliform organisms, most of which are harmless, are present in large numbers in the intestinal tracts of humans and other warm-blooded animals. The normal feces of humans contain between 100,000 to 1,000,000,000 coliform organisms per gram. Tests for coliform organisms are easy to perform and sensitive. No appreciable quantity of fresh fecal material can be present in water and escape detection when the coliform test is properly done.
- b. **Total numbers of bacteria by the standard plate count.** This is a valuable measure of the quality of pool water and, when used with the coliform test, gives important complementary information.

5.5.2 **Interpretation of Test Results.** Authorities differ somewhat on standards for pool waters. One State uses the following standard: "The presence of organisms of the coliform

group, or a standard plate count of more than 200 bacteria per millimeter, or both, in 2 consecutive samples or in more than 10 percent of the samples in a series shall be deemed as unacceptable water quality."

5.5.3 Reasons for Bacterial Limit Violations

- a. **Structure of pool** - The lack of a smooth inner pool surface contributes to the harborage of foreign matter and microorganisms.
- b. **Disinfection** - Inadequate disinfection devices, poor pool algae control, and easy access to foreign matter, such as leaves and other organic matter, may result in positive bacteriological reports.
- c. **Water treatment equipment** - Inadequate filtering is a prime cause of unsatisfactory water.
- d. **Slider control** - The simple matter of overlooking the requirements of cleansing showers for sliders can result in poor bacteriological reports.
- e. **Makeup water** - Poor quality makeup water added to the pool may contaminate otherwise satisfactory water.
- f. **Sampling procedure** - Deviation from recommended sampling procedures may cause false results.

5.5.4 **Action Items.** If the count for either bacteriological test is high, proper chlorination procedures should be reviewed with the slide operator and changes made to improve the situation. The water should be checked daily until the problem is solved.

6.0 Recommendations for Identifying and Troubleshooting Health and Safety Problems During the Operation of Water Slides

Identifying potential health and safety problems with slide operations is detailed in sections 2.0 and 5.0. Finding the root of these problems may require:

- a. A careful review of all records kept by the operator.
- b. Personal discussions with employees.
- c. On-the-site observations of typical job operations of each employee.
- d. Personal observations of the site with regard to general maintenance.
- e. Personal observations of how large crowds are handled by the employees.
- f. Personal observations of how maintenance is carried out on the circulation, filtration, and sanitation systems.
- g. Personal observations of the flumes, walkways, decks, and stairways during operation and during shutdown.

In general, health and safety problems experienced with large water slides may be tied to both initial design and operator proficiency. For the most part, however, design problems

will be evident immediately, and they can be identified and resolved by specific maintenance, warnings, or structural changes. Operator proficiency, however, will continually vary, depending upon the training and conscientiousness of both the operator and his or her employees.

Therefore, a plan of frequent (weekly) and thorough inspections of these facilities by local health officials is recommended, with careful follow-up on items found deficient in earlier inspections. If possible, the local health authority should specify that at least one person on each shift at these facilities be a trained swimming pool operator and that detailed records and logs of all operational and sanitation activities be kept for review by local health authorities.

Because of the high flow rates and the design of slides, the hourly testing for chlorine residual and pH should be borne out by the logs the operator keeps. In addition, the operator should be required to keep a detailed log of all reported accidents at the site.

Typical forms for water tests, filter checks, accident reports, and emergency phone numbers are included in this publication (pages 15-19) for reference.

7.0 Emergency Procedures

The need for emergency planning in areas of public recreation has been demonstrated by past experience. Being prepared for problems is the best method of minimizing their consequences. Therefore, a written plan for emergencies should be carefully devised and kept up-to-date. All employees should be trained and drilled periodically in the execution of the plan. During operational hours, a person qualified through American National Red Cross training in both first-aid and life-saving techniques should be on duty at all times.

The emergency plan should encompass crowd control and safe evacuation, drownings, electrical shock, heat prostration, fractures, poisonings, cuts and burns, neck and back or spinal injuries, and exposure to chlorine gas. Each of these situations is addressed in the latest American National Red Cross handbook on first aid, a copy of which should be on hand at the same location as the emergency plan, the first-aid kit, and the emergency telephone numbers.

Each facility should have available the following first-aid supplies:

- **First-Aid Kit.** A standard 24-unit kit stocked and readily accessible for use.
- A stretcher and blankets.
- A standard plywood backboard or other acceptable splint, made to the specifications of the American National Red Cross, for persons with back and neck injuries.

An area or room should be set aside for the emergency care of casualties.

Every facility should have posted by the phone a list of current emergency numbers, such as the nearest available physician, ambulance service, hospital, rescue squad, police department, and fire department.

Of course, one of the most effective methods of control of emergencies is to plan for them in the original design of the facility. Health and safety officials should review and comment on the original plans and layouts before a building permit is issued.

Two types of emergency situations for which evacuation procedures should be developed are:

- Major release of chlorine gas
- Power outage during nighttime operation

7.1 Chlorine Gas Release

Gas masks should be provided at a point accessible to the operator, generally immediately outside the chlorine room door. With low concentrations of chlorine in the air, front-mounted or back-mounted gas masks equipped with a chlorine-type cannister may be used. With high concentration, however, the preferred means of respiratory protection is a self-contained breathing apparatus, with a full face piece and a cylinder of air or oxygen carried on the body. The apparatus should be the pressure-demand type, in which the pressure inside the face piece is positive during both inhalation and exhalation. If replaceable cartridges are used in the mask, specific instructions should be posted to replace the cartridge with a new one immediately after each use.

In addition to the general emergency plan, a carefully devised plan specific for chlorine gas should be posted. Personnel should be drilled regularly in executing the plan.

A plan should also be devised for the general evacuation of a facility. Because of variations in slide designs, the most feasible approach lies in each facility's devising an individual plan of action contingent upon approval by local health authorities.

Chlorine can be disposed of through a standby alkali absorption system. A suitable tank capable of holding the required alkaline solution should be provided. The alkali should be stored so that a solution can be readily prepared when needed. Chlorine should be passed into the solution through a connection properly submerged and weighted to hold it under the surface. The contents of a full 100-pound cylinder of chlorine can be absorbed in 300 gallons of water or 125 pounds of caustic soda dissolved in 40 gallons of water.

7.2 Power Outage

Each facility should have an emergency plan for use in the event of a nighttime power outage.

Battery-operated emergency lighting packs are available as standard building electrical items. In addition, portable lights and bullhorns should be available to personnel at all times, and an evacuation plan should be devised. Personnel should be drilled regularly in execution of the plan.

The focal point of any such plan **must** be the immediate cessation of use of the slide and the lower pool once the water supply is cut off.

8.0 Typical Posted User Safety Warnings for Slide Operational Use

- a. No running, standing, kneeling, rotating, tumbling, or stopping in flumes or tunnels.
- b. No diving from flume at any time.
- c. Never use this slide when under the influence of alcohol or drugs.
- d. Only one person at a time. Obey instructions of top pool supervisor and lifeguard at all times.
- e. Never form chains unless authorized by slide manager or by posted instructions.
- f. Keep hands inside the flume.
- g. Leave the landing pool promptly after exiting from slide.
- h. Keep all glasses, bottles, and food away from pools.

**FORM A
TYPICAL FIRST-AID REPORT**

Location _____ Date _____

Please check one () Guest () Employee _____ Time _____ a.m. _____ p.m.

Name of Victim: _____ Age _____

Address _____

City _____ State _____ Zip _____

Phone _____

What Happened – Victim Statement: _____

As the victim of this accident, I hereby certify that the above statement is true to the best of my knowledge.

Signature of Victim: _____

Location of Accident: _____

Name of Witness: _____

Name _____

Address _____

City _____ State _____ Zip _____

Phone _____

Statement of Witness: _____

Describe Injury: _____

On-Site Treatment: _____

Was Ambulance Called? _____ Yes _____ No

Attending Employee on Duty: _____

Statement: _____

Manager on Duty: _____

Statement: _____

Note: If you need more space for witnesses, write information on the back of this report.

DIRECTIONS: This report must be filled out completely and accurately, with the original report to be mailed each Monday to the health authority along with the Daily Reports.

Blank Page

FORM B
TYPICAL DAILY WATER QUALITY LOG

Location: _____ Weather: _____

Date: _____

Day: _____

WATER TEST AND FILTER CHECK

Time	Chlorine Count	pH	Water Clarity	Backwash	Temperature	Initial
10:						
11:						
12:						
1:						
2:						
3:						
4:						
5:						
6:						
7:						
8:						
9:						
10:						
11:						
12:						

Blank Page

FORM C
EMERGENCY PHONE NUMBERS

Location _____

POLICE _____ SHERIFF _____

HWY PATROL _____ AMBULANCE _____

FIRE DEPT. _____ HOSPITAL _____

PLUMBER:

Company _____ Phone _____

Person _____ Home Phone _____

Other Emp. _____ Home Phone _____

GENERAL CONTRACTOR:

Company _____ Phone _____

Person _____ Home Phone _____

Other Emp. _____ Home Phone _____

ELECTRICIAN:

Company _____ Phone _____

Person _____ Home Phone _____

Other Emp. _____ Home Phone _____

SWIMMING POOL SUPPLY:

Company _____ Phone _____

Person _____ Home Phone _____

Other Emp. _____ Home Phone _____

VENDING MACHINE COMPANY:

Company _____ Phone _____

Person _____ Home Phone _____

Other Emp. _____ Home Phone _____

Blank Page

GLOSSARY

Backwash — The process of thoroughly cleansing the filter media and elements, by reverse flow.

Backwash Cycle — The time required to thoroughly backwash the filter media and elements, and the contents of the filter vessel.

Backwash Rate — The rate of application of water through a filter during the cleaning cycle, normally expressed in U.S. gallons per minute per square foot of effective filter area.

Cartridge — A replaceable porous element.

Depth-Type Cartridge: A filter cartridge, with media not less than $\frac{3}{4}$ inch (.18 cm) thick, which relies on penetration of particulates into the media to achieve their removal and to provide adequate holding capacity for the cartridge.

Surface-Type Cartridge: A filter cartridge, with media less than $\frac{3}{4}$ inch (.18 cm) thick, which relies on retention of particulates on the surface of the cartridge to achieve their removal.

Deck, Aboveground — Any structure that is on top of or adjacent to the outer edges of the landing pool wall that can support one or more persons in a sitting or upright position.

Decks — Those areas surrounding a pool or flume which are specifically constructed or installed for use by sliders.

Effective Filter Area —

Permanent Media Type: The effective filter area is the cross-section area of the filter surface that is perpendicular to the flow direction.

Diatomaceous Earth Type: The effective filter area of the septum shall be that part of the septum which will accept the full thickness of the precoat* and through which the design filter flow will be maintained during filtration.

Cartridge Filter: The total effective filter area shall be that cartridge area which is exposed to the direct flow of water. This excludes cartridge ends, seals, supports, and other areas where flow is impaired.

Factor of Safety — The ultimate load divided by the safe load or the ultimate strength divided by the allowable stress.

Filter — A device that separates solid particles from water by recirculating it through a porous substance.

Permanent Media Filter: A filter made of media that can be regenerated and will not have to be replaced.

Diatomaceous Earth Filter: A filter with a thin layer of filter aid as filter medium that periodically must be replaced.

Cartridge Filter: A filter with a porous cartridge as filter medium.

Filter Agitation — The mechanical or manual movement to dislodge the filter aid and dirt from the filter element.

Filter Cycle — The operating time between cleaning or backwash cycles.

Filter Element — A device within a filter tank designed to entrap solids and conduct water to a manifold, collection header, pipe or similar conduit. Filter elements usually consist of a septum and septum support.

Permanent Filter Media: A finely graded material (such as sand or anthracite) which removes filterable particles from the water.

Filter Aid: A type of finely divided medium used to coat a septum type filter — usually diatomaceous earth, processed perlite, or similar material.

Filtration Flow — The rate of flow, in volume per time (gpm, gph), through the filter system installed according to manufacturer's instructions with new clean media.

Filtration Rate — The rate of filtration of water through a filter during the filter cycle expressed in U.S. gallons per minute per square foot of effective filter area.

Floor — The interior bottom surface of the splash pool, consisting of that surface from a horizontal plane up to a maximum of a 46° slope.

Flume — An inclined channel containing water and providing a safe transit path for conveying people.

JTU — Jackson Turbidity Unit, a means of measuring water clarity.

Loads — Loads are classified as static and dynamic. Static loads are forces that are applied slowly and then remain nearly constant. One example is weight, or dead load. Dynamic loads are forces that vary with time.

Pinching Hazard — Any configuration of components that would pinch or entrap the fingers or toes of a child or adult.

Primary Structural Members — Any part of the flume or pool structure that carries or retains any static load or stress caused by water pressure or structure weight.

Puncture Hazard — Any surface or protrusion that would puncture a child's or an adult's skin under casual contact.

Removable — Capable of being taken away from the main unit with the use of only simple tools, such as a screwdriver, pliers, or wrench.

Safety Walls — That part of the flume designed to keep a slider within the geometric confines of the flume.

Secondary Structural Members — Any part of the flume or pool structure that is not subject to a load caused by water pressure or structure weight (that is, rigidizing members)

*Defined under "Additional Technical Terms."

Septum – That part of the filter element consisting of cloth, wire screen, or other porous material on which the filter medium or aid is deposited.

Shallow Areas – Portions of a pool ranging in water depth from 3 feet (91 cm) to 5 feet (1.52 m).

Splash Pool – A landing pool at the end of the slide from which bathers exit to the deck.

Spray Rinse, Mechanical – A fixed or mechanically movable spray system which directs a stream of water against the filter surface, causing the filter aid and accumulated dirt to dislodge into the empty tank.

Recessed Steps – A riser/tread or series of risers/treads extending down from the deck with the bottom riser/tread terminating at the landing pool wall, thus creating a “stairwell.”

Recessed Treads – A series of vertically spaced cavities in the landing pool wall creating step holes.

Stress – Force per unit of area.

Tamperproof – A term indicating that tools are required to alter or remove portions of the equipment.

Top Pool (or Starting Pool) – A shallow trough or pool at the top of the slide wherein the slider begins his or her descent.

Toxic – Having an adverse physiological effect on humans.

Tread Contact Surface – Foot contact surfaces of ladder, step, stair, or ramp.

Turnover – The period of time (usually in hours) required to circulate a volume of water equal to the volume of water in the landing pool.

Wall – That structure that supports the landing pool liner or the surface of a flume that is within 45° of vertical.

Wall Closure – The fastening device that connects the flume wall ends.

Water Line – The water line is defined in one of the following ways:

- a. Skimmer System – The water line shall fall in the mid-point of the operating range of the skimmers.
- b. Overflow System – The water line shall be established by the height of the overflow rim.

ADDITIONAL TECHNICAL TERMS*

Cold Crack – The temperature at which the liner or flume material will physically crack when folded 180° on itself. See American Society for Testing Materials (ASTM) Specification D. 1790, “Brittleness, Temperature of Plastic Film by Impact,” revised 1970.

Edge Guards – Shields designed to cover sharp edges on flumes, tunnels, or railings.

Filter Vacuum (or Suction) – A filter which operates under a vacuum from the suction of a pump.

Freeboard – The clear vertical distance between the top of the filter media and the lowest outlet of the upper distribution system in a permanent media filter.

Lower Distribution System (Underdrain) – Those devices used in the bottom of a permanent media filter to collect the water uniformly during the filtering and to distribute the backwash uniformly during the backwashing.

Precoat – The coating of filter aid on the septum of a diatomite-type filter at the beginning of each filter cycle.

Upper Distribution System – Those devices designed to distribute the water entering a permanent media filter so that the media will be prevented from moving or migrating. Unless other means are provided, this system will also properly collect water during filter backwashing.

*The terms in this list do not appear in the text, but they are relevant to the recreational water flume industry.